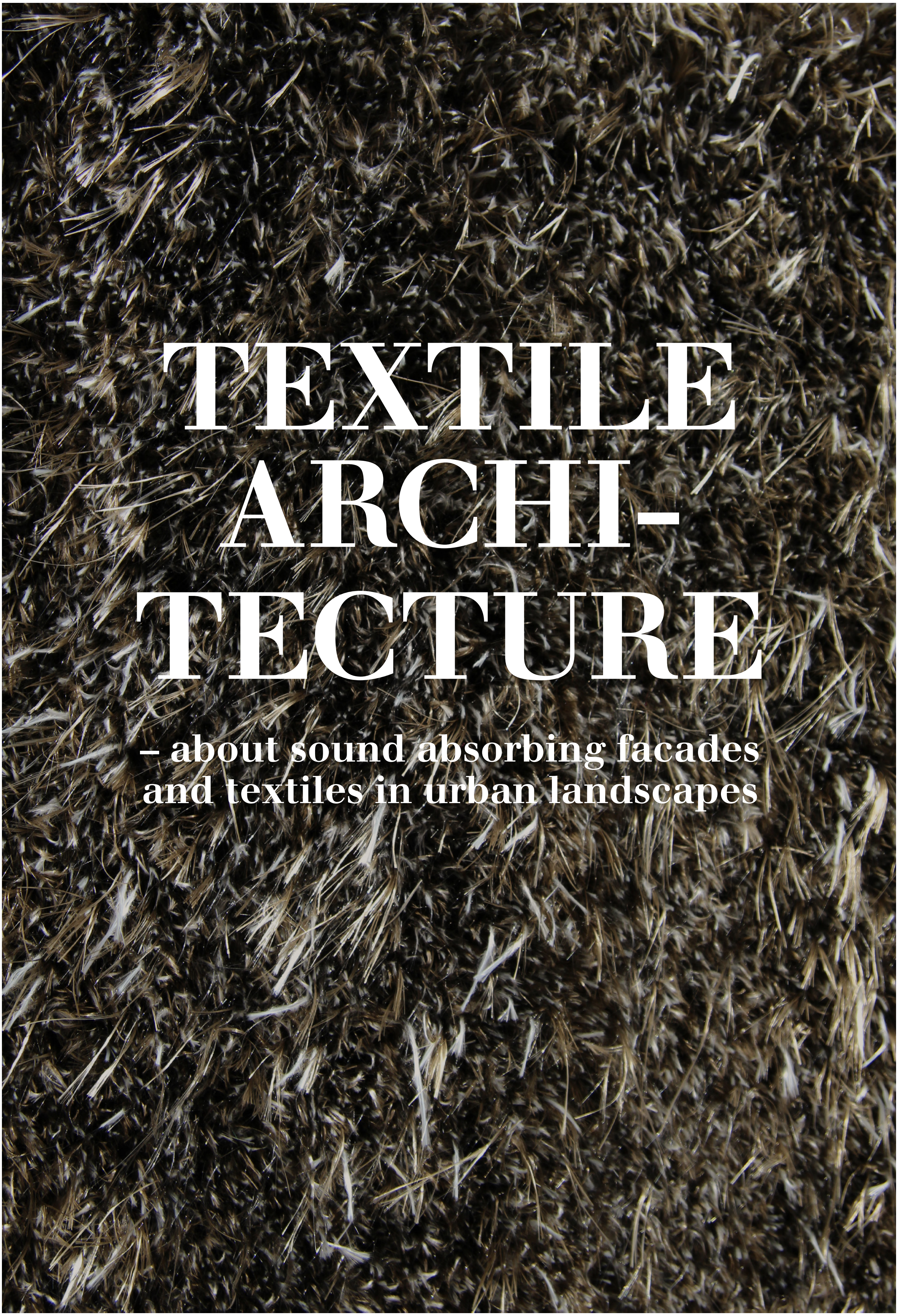


# TEXTILE ARCHI- TECTURE

**– about sound absorbing facades and textiles in urban landscapes**

# TEXTILE ARCHITECTURE – ABOUT THE PROJECT

**The exhibition »Textile architecture« features the result of how two architects and a textile designer have collaborated and experimented with designing textile modules to improve the sound landscape in urban spaces.**

**The exhibition is a result of an artistic research project, »Urban Materiality – Towards New Collaborations in Textile and Architectural Design«, with funding from The Swedish Research Council (Vetenskapsrådet) /Artistic research, that is ongoing from 2016 to 2019.**

The curtain and the carpet are used as metaphors and the interior and exterior change place. Facades are dressed by textile modules, and are based on architect Gottfried Semper's principle of »dressing« (bekleidung) from the 19th century, but also on Japanese architecture where spaces are formed through layers that interact.

Today, building facades are often designed to be perfect, and facade materials are replaced prematurely, even though the materials have a longer life. We want to change the approach to facade materials, and also demonstrate sustainable alternatives. The woven and hand tufted facade modules can temporarily patch facades during building renovations or become parts of new facades.

Using textiles outdoors in facades is unexpected and evokes wonder – can a textile facade module resist outdoor climate? A starting point in the project has been to design textile »disturbances« in the urban landscape, which can give rise to positive experiences of something »non-perfect«. Here, the project connects to aesthetic approaches in the Japanese tea culture. The »incomplete« tea bowls, used in the Japanese tea ceremony, evoke wonder through the unsymmetrical form and the crackled glazing. In this way, bridges can be built between consciousness and objects.

The modules contribute to the absorption of sound in noisy urban environments. In the project, maps of »soundscapes« were made to find the sonic identity of a place, which then was analysed through the use of a number of sonic effects. This is to identify which sounds and sound frequencies that are desirable to dampen.

The exhibition also raises the question of what textile architecture is and can be. A slide show with various interpretations from both textile design and architecture is shown, for example projects by the design studio Inside Outside | Petra Blaisse and the architectural office Kengo Kuma and Associates.


**The research project is placed at HDK – Academy of Design and Crafts and participating researchers are:**

**Kristina Fridh, architect, PhD and researcher, HDK – Academy of Design and Crafts, University of Gothenburg (project leader).**

**Margareta Zetterblom, textile designer, PhD, researcher and senior lecturer, The Swedish School of Textiles, University of Borås.**

**Paula Femenías, architect, Associate Professor and researcher, Building Design, Department of Architecture and Civil Engineering, Chalmers University of Technology.**


Facade, »Exterior Curtain«, Shipyard 1862 in Shanghai, Kengo Kuma and Associates. *Photo: Kristina Fridh.*

The curtain, »Curtain Wall«, Casa da Música in Porto, Inside Outside | Petra Blaisse. *Photo: @ Inside Outside.*

# SOUND AND ACOUSTICS IN URBAN ENVIRON-MENTS

Textile modules have been designed to dampen unwanted sound in a place in central Gothenburg, the area along the street Södra Vägen. The place is burdened by traffic noise with low sound frequency, but also by sounds with higher frequencies.

One way to identify the sonic identity of a place is to make a soundscape map. The method has been developed by the composer and researcher Murray Schafer. The soundscape encompasses a person's perception of natural sounds, such as from wind and rain, but also people's conversations and sounds from buses, cars and other technology.

Observations were made during twelve hours. The study of the soundscape showed that the most dominant sounds were low sound frequencies from the traffic. When these sounds decreased, sounds with higher frequencies from squeaky vehicles, birds and people's footsteps and speech became more dominant. Thus, the soundscape varies over time.

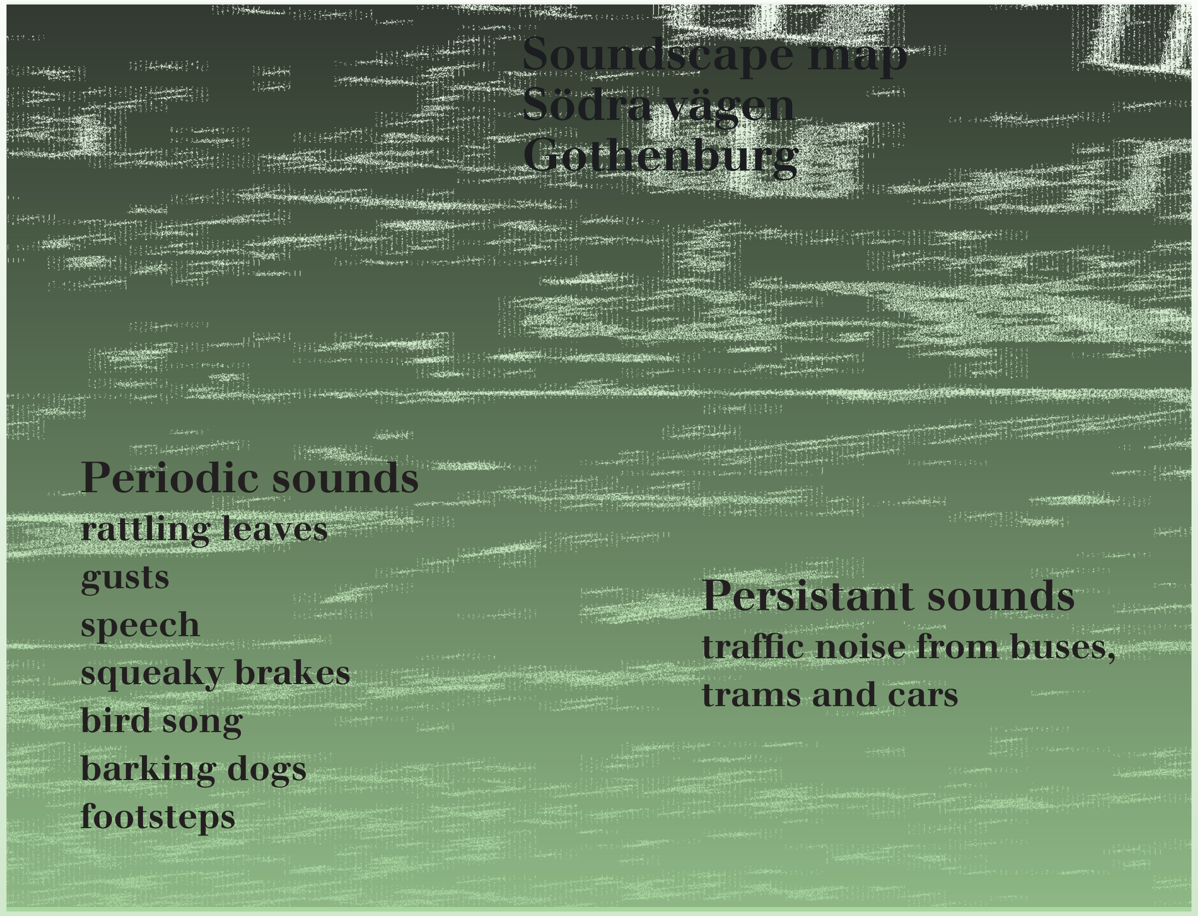
To analyse the soundscape map, a number of »sonic effects« were used, which is a tool developed by CRESSON (Centre for research on sound space and urban environment). They use six groups of sonic effects and within these groups, there are sixty-six different sonic effects. The listener uses them to describe, analyse and understand experiences of sounds in urban spaces.

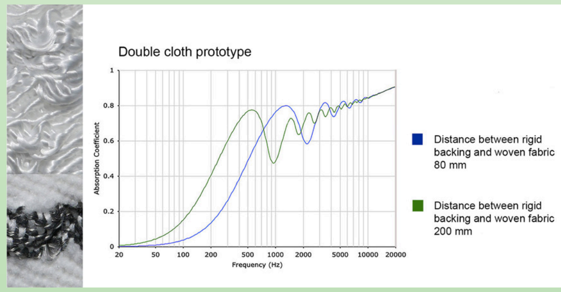
Two of the groups were found to be appropriate to apply for the soundscape at Södra Vägen. »Elementary effects« are tools for the sound material in itself, for example, reverberation and echo. The second group was »memo-perceptive effects« that are linked to perceptive organisation and memory, and to how a person perceives the sounds in an actual situation. This group comprises »metabolic« and »ubiquitous« sonic effects.

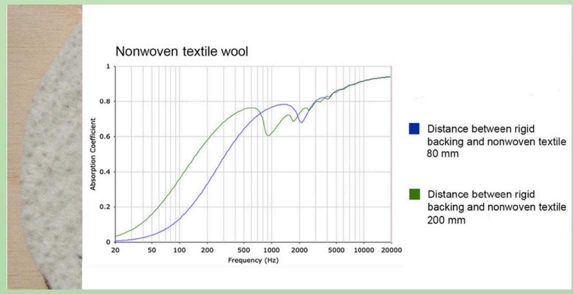
The urban soundscape at Södra Vägen can be described as »metabolic«, since sudden, specific sounds were heard during a period of time against a background of more monotonous, subdued sounds. The sonic structure is experienced as unstable, and the sounds vary between foreground and background over time.

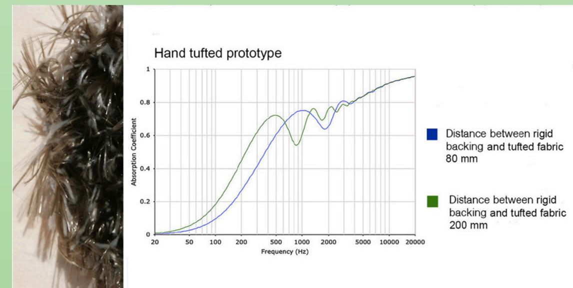
It was also difficult to identify where a sound emanate from. From »elementary effects«, the echo effect was used – sounds were echoed at Södra Vägen during a long period of time, which resulted in the sounds being mixed in a sound chaos.

Thus, the environment at Södra Vägen shows big acoustic variations over time, which is often found in urban environments. The sound absorbing modules, which consist of several interacting textiles, have been designed to dampen both low frequency sounds and short-lived, high frequency and intrusive sounds. The modules should also subdue the echo effect and make it easier to identify from which direction a sound is coming. This would stabilise the sound environment and make it easier to orientate in the soundscape.




**Top:** Example map of the soundscape at Södra Vägen. *Illustration: Margareta Zetterblom.*
**Bottom:** Acoustic tests for sketches double cloth (weave), hand tuft and nonwoven wool to examine the sound absorbing properties. Method of measurement and diagram http://www.acousticmodelling.com/.

# MATERIALS AND TECHNIQUES

Textile materials for outdoor use impose new challenging material requirements, since the textiles must withstand UV radiation, wind, moisture, cold, heat, fire and air pollution. In the project, the synthetic fibre Trevira CS has been used, which is flame retardant. By adding an organic phosphorus component at the molecular level in the manufacture of Trevira CS fibres, the flame retardant does not weaken during wear and aging or if the fibre is exposed to moisture. Two types of Trevira CS have been used: Trevira CS Pemotex and Trevira CS Outdoor. In the sketch work, white Trevira CS Pemotex yarn and white polypropylene yarn have instead been used.

One of the most important factors in designing a sound absorbing textile material is to be able to control the density of the fabric, which is why Pemotex yarn has been used. The yarn is flame retardant, but also has the property of contracting when it is exposed to heat. In the manufacture of the yarn, both polyester fibres and thin melt threads are used. Pemotex yarn contracts at 70 degrees. In textile designs, where Pemotex is used together with less heat-sensitive yarns, the Pemotex yarn can shrink a flat textile into a permanent three-dimensional textile.

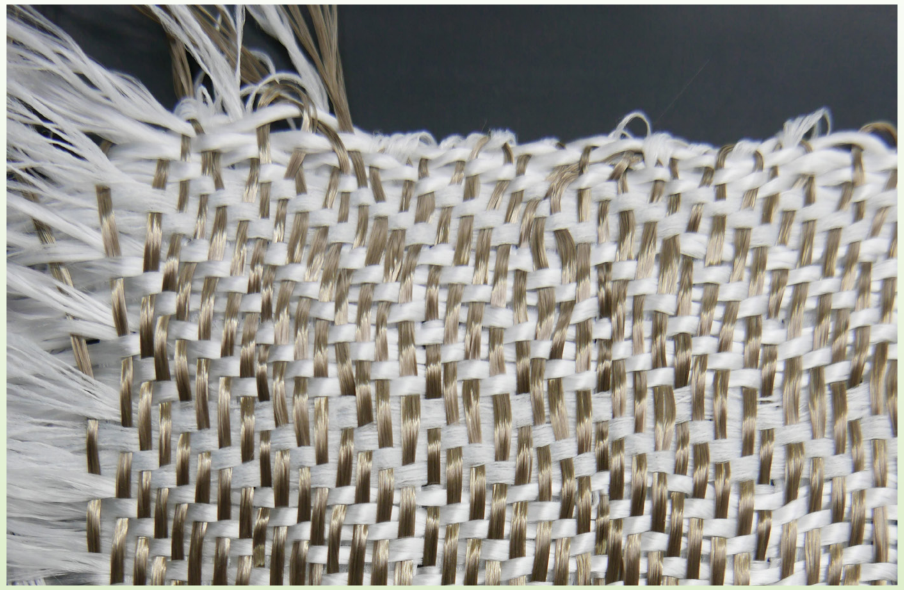
The Trevira CS Outdoor yarn has the properties of a Trevira CS yarn, but can also withstand exposure to UV radiation without fading or becoming brittle, high humidity and saltwater. Already in the solution in the manufacture of the fibre, in addition to fire protection agents, colour pigments and UV protection are added.

We have also worked with basalt yarn, made from the volcanic rock basalt. Basalt yarn withstands high and low temperatures and is resistant to fire. The yarn does not rust, dampen sounds and does not absorb water. Basalt fibres are made from a mixture of different minerals and basalt, which is crushed and melted into long thin threads.

Glass fibre yarn has been used, because it is a yarn that can withstand fire, is resistant to sunlight and chemicals, heat insulating and air purifying. Glass fibre is produced by melting sand, soda and sandstone and extracting it into fibres.

We have worked with the natural fibre wool as it is fire and water resistant. A thick wool material that is exposed to a powerful heat source does not start burning but only glow. Nonwoven fabrics made of wool work well for the design of sound absorbing textiles, since the wool fibre is covered by epidermis scales, which can be likened to barbs. The epidermis scales hook into each other during mechanical processing, which allows the wool fibres to be milled to the desired thickness and density.

In parallel with the design work and the making of prototypes, samples have been tested acoustically to examine the sound absorbing properties of the textiles in relation to different sound frequencies. In the measurements, a so-called air-flow resistance instrument has been used.



**Top:** Sketch double cloth, Trevira CS Pemotex, basalt yarn and polypropylene yarn.
**Middle:** The same sketch double cloth after shrinkage through heat exposure.
**Bottom:** Yarns from left to right: Trevira CS Pemotex, Trevira CS Outdoor, glass fibre yarn and basalt yarn. *Photo: Margareta Zetterblom.*

**Top:** Nonwoven textile wool.
**Middle:** Sketch double cloth with two different sides, Trevira CS Pemotex, basalt yarn and polypropylene yarn.
**Bottom:** Sketch double cloth with two different sides, Trevira CS Pemotex, glass fibre yarn and polypropylene yarn. *Photo: Margareta Zetterblom.*

**Top:** Sketch double cloth with two different sides, Trevira CS Pemotex, basalt yarn and polypropylene yarn.
**Middle:** Hand tufted sketches with different mixes of glass fibre and basalt yarn.
**Bottom:** Sketch double cloth for prototype 2, Trevira CS Pemotex, Trevira CS Outdoor and basalt yarn. *Photo: Margareta Zetterblom.*

# PROTOTYPE 1 and 2: THE EXTERIOR CURTAIN

Prototype 1 and 2, the exterior curtain, is intended to be put on a facade temporarily or to dress it permanently, which is related to »dressing«. The outer layer consists of a double cloth (weave), which makes it reversible. The inner layers consist of two layers of nonwoven textile in wool. The module is mounted at a distance from the facade and there is also empty space in-between the different layers. This increases the absorption of sound.

The outer woven layer absorbs middle and high frequency sounds best, but the combination of different layers means that sounds with various frequencies can be absorbed, from low frequency to high frequency sounds. The outer layer should not be too dense, since soundwaves must be able to pass to be absorbed by the inner layers of nonwoven, which dampen low frequency sounds well. The three-dimensional surface of the module diffuses the sound waves, which increases the absorption.

**Prototype 1:** (white/black): Trevira CS Pemotex, Trevira CS Outdoor and glass fibre yarn. Nonwoven textile wool.

**Prototype 2: (**black): Trevira CS Pemotex, Trevira CS Outdoor and basalt yarn. Nonwoven textile wool.

**Top:** Detail prototype 2.

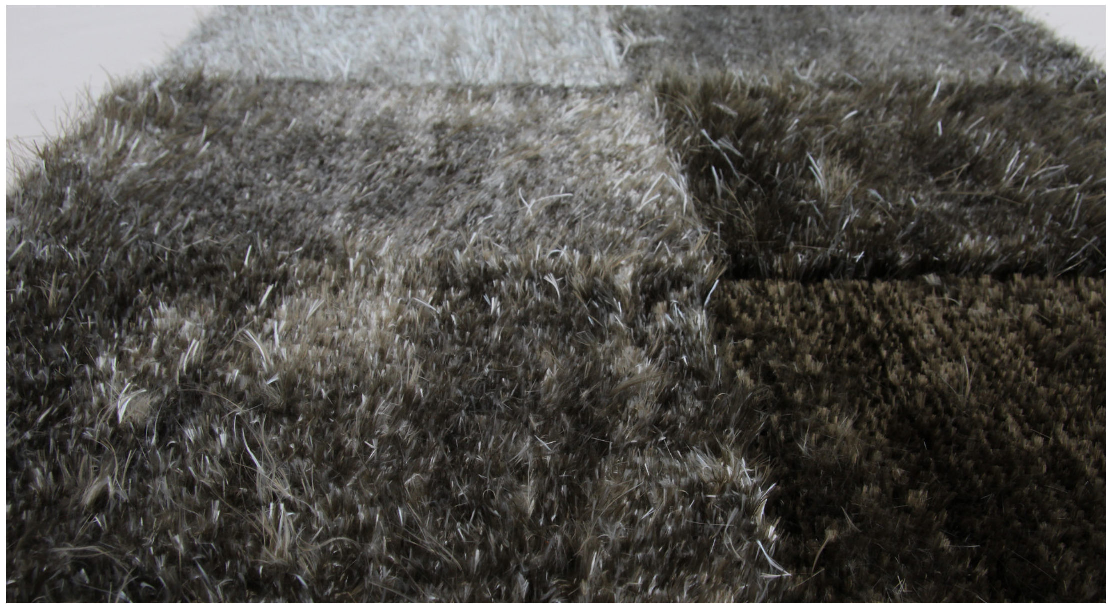
**Bottom:** The outer layer prototype 1 (white/black) and 2 (black). The textile has been permanently shrunk by heat. The outer layer consists of three parts, ca 600 x 600 mm. *Photo: Kristina Fridh.*

# PROTOTYPE 3 and 4: THE CARPET

Prototype 3 and 4, the carpet, also relates to »dressing« and can dress a building's facade or patch it if there is damage to the facade layer. The outer layer is a hand tufted textile. The inner layers consist of two layers of nonwoven textile in wool. The module is mounted at a distance from the facade and there is also empty space in-between the different layers. This increases the absorption of sound.

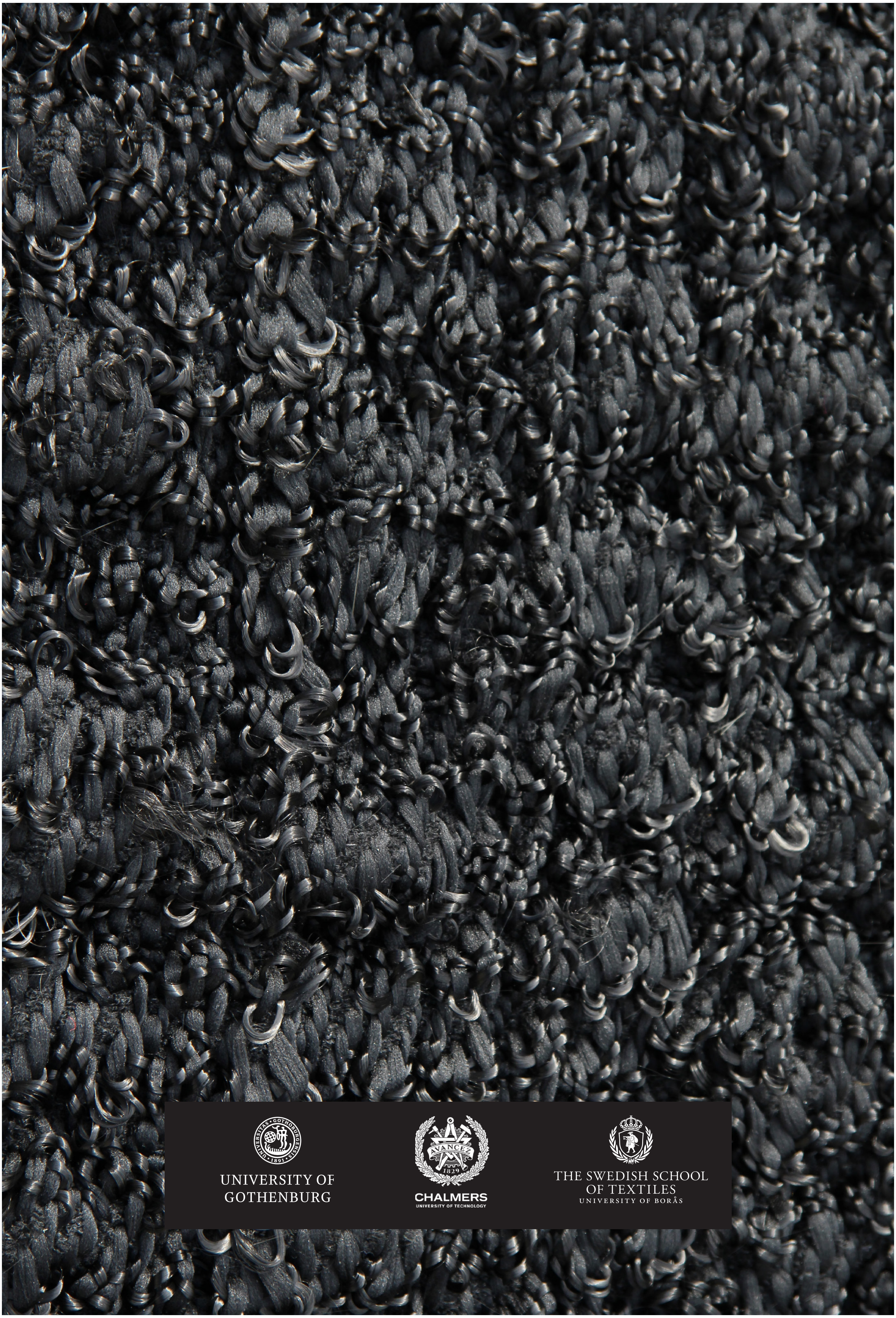
The different layers allow both low frequency sounds, such as traffic noise, and high frequency sounds, such as squeak from traffic and loud, shrill voices, to be dampened. The outer tufted textile absorbs low frequency sounds slightly better than the woven textile of the exterior curtain, prototype 1 and 2.

**Prototype 3 and 4:** basalt yarn and glass fibre yarn. Variations of percent basalt yarn and glass fibre yarn in the modules as well as different pile heights. Non woven textile wool.



**Top:** Detail prototype.

**Bottom:** The outer layer prototype 3 and 4. Varying mix of yarns and pile height. The outer layer consists of three parts, ca 600 x 600 mm. *Photo: Kristina Fridh.*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